

Quantifying the Environmental Benefits of Green Power

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Alden Hathaway
Environmental Resources Trust, Inc.
&
Colin High
Resource Systems Group Inc.

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Market Benefits of Quantification

Why do we need to quantify?

- Renewable energy cannot get **clean air credit** without rigorous and accurate quantification of specific air emissions reductions achieved through renewable energy generation.
- Quantification gives renewable energy a **competitive edge** in The marketplace, by valuing its emissions reductions for NOx and other emissions trading opportunities
- In certain regional power markets, this empirical and quantitative approach focused on net emissions reductions achieved by the green power source generation can more effectively **spur green power market development** than the use of “average system mix” emission reduction estimates which include nuclear and large hydro plants that are not displaced by renewable generation

How?

- Use the Power Plant Dispatch Ranking Methodology to measure NOx emission reductions and other reductions created through renewable energy back down of fossil plants on the margin.

Examples:

- EPA Innovative Measures/SIP credit
- CCX Emissions Trading
- Other Emission Credit Program

New ERT Environmental Report



ANNUAL ECOPOWER® ENVIRONMENTAL REPORT FOR THE CITY OF CHICAGO FOR 2002

21 February 2003



331 Gleason Drive, White River Junction, Vermont 05001

EcoPower® Environmental Report,
21 February 2003

Resource Systems Group, Inc.
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Table 1: Annual EcoPower® Environmental Report for City of Chicago

	Sources of EcoPower							Total All Sources ⁶
	BioGas ¹	BioCrude ²	Wind ³	Solar Direct ⁴	Geo- thermal ⁵	Tidal/ Wave ⁶	Small Hydro ⁷	
EcoPower Generated (MWh) ⁸	01,101	—	—	0	0	0	0	01,101
EcoPower Sold (MWh) ⁹	01,101	—	—	0	0	0	0	01,101
Estimated Air Emissions Savings from Generation of EcoPower ¹⁰								
	BioGas ¹	BioCrude ²	Wind ³	Solar Direct ⁴	Geo- thermal ⁵	Tidal/ Wave ⁶	Small Hydro ⁷	Total All Sources ⁸
Greenhouse Gases (lb CO ₂ -equivalent) ¹¹	136,512,000	—	—	0	0	0	0	136,512,000
Criteria Air Pollutants (lb) ¹²								
Sulfur dioxide ¹³	424,188	—	—	0	0	0	0	424,188
Nitrogen dioxide ¹⁴	45,203	—	—	0	0	0	0	45,203
Particulate matter (Total) ¹⁵	12,226	—	—	0	0	0	0	12,226
Volatile Organic Compounds ¹⁶	4,719	—	—	0	0	0	0	4,719
Total Air Pollutants (pounds) ¹⁷								
1, 2, 3 - Subtotal ¹⁸	0.00001	—	—	0	0	0	0	0.00001
Arsenic ¹⁹	1.25	—	—	0	0	0	0	1.25
Cadmium ²⁰	21.17	—	—	0	0	0	0	21.17
Chromium ²¹	0.39	—	—	0	0	0	0	0.39
Chlorine ²²	3.55	—	—	0	0	0	0	3.55
Copper ²³	69.75	—	—	0	0	0	0	69.75
Disinfection Byproduct ²⁴	0.00004	—	—	0	0	0	0	0.00004
Formaldehyde ²⁵	7.65	—	—	0	0	0	0	7.65
Lead ²⁶	2.67	—	—	0	0	0	0	2.67
Manganese ²⁷	7.55	—	—	0	0	0	0	7.55
Nickel ²⁸	6.21	—	—	0	0	0	0	6.21
Potassium Chloride ²⁹	0.05	—	—	0	0	0	0	0.05
Zinc ³⁰	1.13	—	—	0	0	0	0	1.13
Automobile greenhouse gas emissions (Equivalent to Subtotal) ³¹	11,881	0	0	0	0	0	0	11,881

* Indicates a criteria pollutant. ** Indicates a toxic air pollutant.



Methodology

- Identify the generation displaced on the margin by must run renewable power with:
 - Information from utilities or the ISO
 - Recent past generation and Continuous Emissions Monitoring (CEM) data
 - Dispatch models and transmission constraint data
- Match renewable generation schedule with displaced generation dispatch schedule
- Determine emissions of the renewable energy generation (if any) and displaced emissions from CEMs to calculate net reductions

Results of Chicago Report

- Analysis shows that renewable energy backs down fossil fuel plants, coal, oil, gas rather than nuclear or hydro
- Renewable energy backs down fossil fuel plants because of zero or near zero marginal operating costs
- Analysis utilizes actual power plant dispatch ranking data – specific plants dispatched in order of economic cost

Results of Chicago Report

- *Continued:*
- Analysis compares actual power plant dispatch ranking data and actual continuous emissions monitor data to verify emission and operational changes
- Data based on continuous monitors are current vs. time lag (up to two years) with other methodologies
- Data in Chicago shows 2300 lbs CO₂ per MWh vs. 815 lbs per MWh using "System Mix" calculation

How Chicago Methodology Can Help Decision Making about Clean Air

EcoPower® Environmental Report
21 February 2002

Resource Systems
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Table 1: Annual EcoPower® Environmental Report for the City of Chicago

	Sources of EcoPower						
	Biomass ¹	Biomass ²	Wind ³	Solar ⁴	Geo-thermal ⁵	Tidal ⁶	Small Hydro ⁷
EcoPower Generated (MWh) ⁸	01,100	0	0	0	0	0	01,100
EcoPower Sold (MWh) ⁹	01,100	0	0	0	0	0	01,100
Estimated Air Emissions Savings from Generation of EcoPower ¹⁰							
	Biomass ¹	Biomass ²	Wind ³	Solar ⁴	Geo-thermal ⁵	Tidal ⁶	Small Hydro ⁷
Greenhouse Gases (lb CO ₂) ¹¹	130,000	0	0	0	0	0	130,000
Criteria Air Pollutants (lb) ¹²							
Carbon Dioxide ¹³	404,189	0	0	0	0	0	404,189
Nitrogen Dioxide ¹⁴	92,283	0	0	0	0	0	92,283
Particulate Matter (TSP) ¹⁵	12,444	0	0	0	0	0	12,444
Visible Organic Compounds ¹⁶	4,119	0	0	0	0	0	4,119
Toxic Air Pollutants (lb) ¹⁷							
1, 2-Dichloroethane ¹⁸	0.00001	0	0	0	0	0	0.00001
Arsenic ¹⁹	1.25	0	0	0	0	0	1.25
Benzene ²⁰	30.17	0	0	0	0	0	30.17
Chlorine ²¹	0.36	0	0	0	0	0	0.36
Chloroform ²²	3.08	0	0	0	0	0	3.08
Cyanoide ²³	66.70	0	0	0	0	0	66.70
Dioxin and Furans ²⁴	0.00004	0	0	0	0	0	0.00004
Formaldehyde ²⁵	7.65	0	0	0	0	0	7.65
Lead ²⁶	2.67	0	0	0	0	0	2.67
Mercury ²⁷	7.08	0	0	0	0	0	7.08
Nickel ²⁸	6.21	0	0	0	0	0	6.21
Polycyclic Organic Matter ²⁹	0.08	0	0	0	0	0	0.08
Zinc ³⁰	1.13	0	0	0	0	0	1.13
Automobile greenhouse gas emissions (lb CO ₂) ³¹	11,891	0	0	0	0	0	11,891

* Indicates a criteria pollutant. ** Indicates a toxic air pollutant.

- Use Power Plant Dispatch Analysis methodology to validate NOx emission reductions created through renewable energy back down of fossil plants.
- For example: Use EPA Stationary Source Voluntary Measures Policy to provide SIP credit to NOx emission reductions.



Quantification of Emissions Reductions

- Prospective quantification- based on renewable plant specifications and existing plant dispatch scheduling for the past 12 months - used for marketing and revenue estimation and preliminary emissions reduction estimates.
- Retrospective verification –based on actual power produced and actual emissions reduction for the verification period – used to meet emission reduction credit requirements

Environmental Attributes Represent a Product's Environmental Impact

As water has no calories, wind has no emissions and, thus,
it's label is zero environmental attributes

Wind



Fossil Fuel



However, Replacing Fossil Fuel with wind yields emission reductions

Wind

Fossil Fuel

(emissions = calories)

NO _x	
SO _x	
CO ₂	



Steps in the Quantification and Verification Process

Common to Prospective and Retrospective Verification

- Obtain schedule of renewable power production- time of day / week / month
- Obtain list of conventional units on demand (operating on the margin) from load serving entity (utility).
- Verify the list of units on demand (operating on the margin) by reference to capacity factor, actual generation records or hourly CO2 CEM monitoring data on a sample basis.
- Determine demand schedule priority (back down order)

Steps in the Quantification and Verification Process

Continued

- Obtain emissions data from renewable source if relevant (e.g. landfill gas or biomass but not wind or PV) to calculate emissions / MWh
- Obtain emissions data and generation data for displaced units from CEMs for the relevant time periods to calculate emissions/MWh
- Determine net reductions in emissions attributable to renewable generation by time period.

Chicago Leads the Way



City of Chicago to begin purchasing over 120,000 MWh of Wind from Mendota Hills Wind Plant.

2 Largest Wind Plants in Midwest coming on line 2004.

Chicago Mayor Richard Daley receives a ceremonial EcoPower® Certificate from Commonwealth Edison CEO John Rowe.

New Wind for Chicago



Questions?

Alden Hathaway
Environmental Resources Trust, Inc.

Phone: 202-785-8577

ahathaway@ert.net

or

Colin High
Phone 802-295-4999
chigh@rsginc.com